HGM Method Overview

Introduction by Ed Squiers

Of all the methodologies that are currently in progress or are currently being studied or implemented in a variety of settings, the hydrogeomorphic method (HGM) is probably the leading candidate for a standardized methodology. We have with us today Dan Smith, who's with the Corps of Engineers Waterways Experiment Station. He's going to talk to us about the methodology and give us some background and some of the details of how it works.

Dan Smith, U.S. Army Corps of Engineers Waterways Experimental Station

We've reached a new plateau in wetlands science as of Sunday night. How many of you know how we achieved that? Anybody watch "X-Files"? Anybody catch the little blurb on "X-Files" this Sunday? Mulder, who's one of the FBI guys, was in a small town talking to the local constable. They were researching vampires or something and he said to the officer, "Are there any graveyards, haunted houses, or swamps around here?" The constable said, "Well, we used to have swamps, but the EPA now makes us call them wetlands." [laughter] It's amazing to me that even though the Corps is responsible for the 404 process, the EPA still takes the hit for this wetland regulation stuff. It's wonderful. I don't understand how it happened.

I'm the messenger here, but there are a lot of people involved in the hydrogeomorphic approach. I'm probably the person responsible for the initiation of it 5 or 6 years ago in conjunction with Mark Vinson, but there are a lot of people involved with the HGM approach right now. Probably hundreds–there are at least 20 states that are involved in developing some kind of hydrogeomorphic assessment or approach (more about that later). For those of you who are Web fanatics, or are interested in the Web, the website for the HGM approach is up and running and has a bunch of information on it (more about that later, also).

My objective today is to do a couple of things. First of all, I'm presuming that we have a fairly knowledgeable group in terms of wetlands and all the things that go with wetlands, but I'm going to take a few minutes to talk about some basic terms and concepts that we use in functional assessment. I'm going to give you an overview of the hydrogeomorphic approach. We'll talk about the difference between development phases and application phases of HGM. We'll talk a little bit about classification. We'll talk about the concept of reference wetlands, functional indices, assessment methods or assessment models, and development of application protocols. And then we'll talk about the status of regional guidebook development–how it's going in the United States, where it's being done, and what kinds of things are being done. I may or may not talk about some of the misconceptions that have been generated about the HGM approach. Finally, I want to end with a brief comparison based on my experience between the hydrogeomorphic approach and IBI and its sisters and brothers, and some of the other approaches that are out there to set up where HGM is in relation to these other techniques.

So let's get real basic. What are wetland functions? I define functions as activities or actions that take place inside a wetland ecosystem, stressing the fact that we're talking about the ecosystem. *Ecosystem.* Simply the things that wetlands do. I would argue that wetland functions are a result of the characteristics of the wetland ecosystem itself, and the landscape in which the wetland ecosystem resides. Things like the source of water, hydrologic regime, cell type, topographic relief, vegetative structure, size and position of the landscape, etc. They are also a result of physical, chemical, and biological processes, such as the movement of water, chemical reactions, productivity, decomposition. Those are all things that determine whether a wetland ecosystem performs certain functions. So you've all seen lists like this. We tend to categorize: hydrologic functions such as storage and conveyance of surface and subsurface water, cycling of nutrients, biologically supporting plant communities, providing wildlife habitats, and on the landscape scale, contributing to the mosaic of ecosystems in the landscapes.

This is my "military slide." I'd like to talk about the hierarchy of functions. When we talk about functions in wetland ecosystems, we need to think of a hierarchy in the sense that we could talk about a very general function like elemental cycling, or we could get more specific and talk about nutrient cycling, or the cycling of a specific nutrient like nitrogen, or the process within nitrogen cycling, denitrification. So there's a hierarchy of functions within the ecosystem, but we also need to recognize that there is a hierarchy of functions going the other direction. You can identify a different set of functions as you go from sites and ecosystems to, for example, street regions, larger regions, sub-watersheds for example, or regions and landscapes. So scale is incredibly important when you talk about functional assessment in wetlands. In the past we've really glossed over it, and a lot of the problems we have in trying to define functions and the processes that are influencing functions, are scale-dependent, and we haven't realized that in the past. It's very important to be critical about the definitions you make.

I've said this a lot in different parts of the country; if I were the god of the wetland lexicon, I would like to have the opportunity to remove a phrase from wetland science and wetland ecology–it would be "wetland functions and values." Whoever put those 2 together created mass chaos for all of us down the road. Wetland functions and the value of wetland functions are not the same thing. The value of wetland functions is the beneficial goods and services that result from functions being performed. "Value" is a subjective and a relative concept. What is valuable to the farmer is not what is valuable to the hunter or to the wetland scientist. That's very different from wetland functions, which are objective sets of processes and activities that can be assessed. The hydrogeomorphic approach objectively assesses wetland functions, but it does not assign value to those functions. It's the precursor to the step that you have to make in assigning values. The HGM approach and many other assessments tell you the capacity of a wetland to perform a function; it doesn't tell you whether that's good or bad. You have to make that decision using another set of techniques, perhaps.

This is a diagram you've seen a lot. We have hydrological functions, biochemical functions, and they all can be related in some way to educational activity, development of wood products, base flow/recharges that result from these functions. Another thing that we need to consider is the idea of functional capacity, which as far as I know is maybe not unique to HGM, but it's the first time where this concept has been fully developed and discussed. Functional capacity is simply the capacity of a wetland ecosystem to perform a function. It depends on the characteristics of the wetland ecosystem itself and its surrounding landscape. Similar types of wetlands exhibit a wide range of functional capacity because of natural processes and disturbance, and because of anthropogenic alterations. So we can go to a type of wetland and find that within a wetland type, there's a wide range of functional capacity.

Let's look at functional capacity in a simplified sense, and then we'll bump it up a little higher to an ecosystem sense. In this slide I have a water pump. This water pump has certain characteristics which would be equivalent to ecosystem characteristics, although very simplified. It has size of the parts and other design specs that were put into that pump; it's in a certain condition. It may be very old or very new. If it's a brand new pump, and if it's been put together correctly, it should pump at a certain capacity–it was designed to pump at a certain capacity. That's its functional capacity. But if you just set the pump on the table, and you don't hook it up to a power source, or you don't hook it up to a water source, that pump is not going to achieve its capacity. It can't. It can sit there, but it's not performing the function. If you then hook it up to a power source, and maybe it doesn't have enough power to go at full speed, well, then it won't reach its functional capacity because it's only pumping 50 cubic feet per second instead of 100. So there are internal characteristics as well as external characteristics that influence functional capacity of this pump. Now let's make it a lot more complicated. Let's talk about a wetland ecosystem. The system has its own characteristics–structural characteristics, hydrologic regime, soil type, and lots of other things. It's also sitting in a landscape that has characteristics. Both those things influence the functional capacity of that wetland. If you alter something, you're going to change the functional capacity.

With that said (and we'll come back to those concepts) let's talk about what the hydrogeomorphic approach is. There's nothing new or unique in the hydrogeomorphic approach. Honestly. We stole and plagiarized from every good source that we could find to put it together. The only new thing is the way it's put together–the way the pieces are put together in juxtaposition to each other. It's a collection of concepts and methods used to develop a set of functional indices and protocols for applying those functional indices for the purpose of rapidly assessing the capacity of a wetland to perform certain functions. That's all the hydrogeomorphic approach is. There are a thousand, a million different ways to apply the concepts, the tool of the hydrogeomorphic approach. We in the Corps of Engineers are applying it in one specific way, but other groups are applying it in other ways. So there is no right way. It's not rocket science, it really isn't. If you break it down to its fundamental pieces, it's pretty simple. Every piece is based on something that's been done before. There's a lot of stuff from HEP (Habitat Evaluation Procedure) in it. There's actually a lot of stuff from IBI in it, conceptually, and many other assessment methods that are out there. It was developed based on standing on the shoulders of previous assessment methods. It was designed initially for use in the 404 program. I work in the

Corps of Engineers; we issue permits. That's our mandate, to issue permits for dredge and fill. But in the process of issuing permits, we're supposed to go through a sequence, and that sequence says we're supposed to compare project alternatives; we're supposed to minimize project effects; we're supposed to assess unavoidable impact, determine mitigation requirements, design mitigation projects, and monitor that mitigation. So we tried to develop a tool that could be used at each stage of this sequence. And what came out of it is the HGM approach. John Kusler has done a paper, which you have in your stack, that quite effectively outlines a number of the questions and problems that we dealt with 5 and 6 years ago when we were beginning to develop the hydrogeomorphic approach. Go look at that list, then come back and look at the hydrogeomorphic approach and see if it doesn't address most of those issues.

Subsequent to being developed, HGM has really been embraced, modified, and utilized by a number of different efforts. You'll hear about some of those today or tomorrow. For example, determination of the minimal effects by NRCS, project planning in wetland ecosystem management, adapted to advanced identification, types of things like cumulative impacts, and also educational types of things. I won't go into a lot of detail about this. But there are limitations. I submit to this group that–and you're not going to like it when I say this–the development of an assessment technique that can meet the list of criteria that were given this morning by several of the speakers is impossible. The criteria are mutually exclusive. You will never, in my opinion, develop an assessment technique that Joe Blow off the street can walk in, pick it up, walk out, and do an assessment. I know that's the ideal, but it won't happen. You have to develop minimum standards and requirements for someone doing wetland assessment. A guy off the street will never be able to do this. We have regulators in the Corps who will never be able to do it. You get what you pay for, and if you don't put time and effort into collecting data and analyzing that data for an assessment, what you get out is probably not worthwhile.

There are limitations to HGM. Number one, it does not assess offsite impacts. The Corps of Engineers is charged with doing an assessment of a site, and based on the 404 regulations, you go to the site and assess the changes to that site as a result of a project. That's the way we developed HGM–to do site-specific assessment and to monitor change. It is not designed to assess cumulative impacts. We're also charged, in 404, to do a cumulative impact assessment. Does anybody know of a successful cumulative impact assessment, anywhere in the United States? Please, I want to talk to you if you do. I'm talking watershed scale; where they've gone in and looked at all the wetlands in the watershed and made a permanent decision based on the value of a specific kind of wetland in that watershed. It hasn't happened yet. HGM will help you do that, but it wasn't designed to do that specifically. It was not designed to assign value to wetland functions, as I've already said. It was not designed to compare different wetland types. We'll talk about classification in just a second. But HGM will not allow you to mitigate for a riparian wetland in one place with a depressional wetland somewhere else. It won't tell you how to make that translation. It will tell you how to mitigate for a riparian wetland with a riparian wetland, but it won't tell you how to mitigate for it at a depressional wetland. That's a value judgement and a cumulative-impact, watershed scale question that HGM doesn't deal with.

However, I think the results in HGM give you information that is necessary to answer these kinds of questions. It gives you fundamental information that you need. It's important to recognize at the very outset that HGM is really 2 things: it's a development process, and it's an application process. The development process involves the classification and identification of reference wetlands, development of functional indices, and development of separate protocols to actually apply those indices at a project site in a 404 action, or some other kind of action. The application phase is when the end user, in my case, the 404 regulator, takes the product from the development phase. In my case, that would be a regional guidebook. The regional guidebook lays out an exact procedure for how to go out and do an assessment in a particular kind of wetland. That's the application phase. I won't talk much about that today; I'm going to talk about the development phase. But recognize there's a development phase that has to precede any kind of use of HGM and/or 404.

Why a 2-phase approach? Well, because we know or we have experienced over the past 10 years, that it takes a lot more to develop an assessment technique than will ever be done in a Corps district. They won't do it. They'll use the tool that we or someone else supplies to them. They've been asking for that tool for years. So we leverage the knowledge and experience of wetland experts, and data from a set of reference wetlands, against the inherent constraints of the review process. The 404 regulator has limited time, resources, personnel, and technical expertise. How many times have you heard the regulator tell you he's got a stack of permits and only a few personnel, and he needs a tool to do them all with? It's whining, but it's legitimate.

Let's talk about classification. There are 4 fundamental components of a hydrogeomorphic approach. There's wetland classification–reference wetlands, functional indices, assessment models, and assessment protocols, and I'll talk about each of those in a fair amount of detail. Hydrogeomorphic classification, by the way, sits out by itself. It was developed independently, and we were instrumental in getting it developed, because we knew we needed a classification system for the hydrogeomorphic approach. But it sits out there by itself, and there are lots of people looking at hydrogeomorphic classification and saying, "Hey, that's really good. It works for us for this different application." IBI, the group that's currently trying to work out the differences and similarities between IBI and HGM, is saying, "We can't think of a better way to classify wetlands for IBI kinds of approaches, so let's try the hydrogeomorphic kind of classification." By the way, IBI is the Index of Biological Integrity. That's the whole group of techniques that's been used primarily in developing water quality standards for streams. There's an attempt right now to develop water quality standards for wetlands. They're looking at taking IBI out of the stream and up into the wetlands; and how to do that, developing indices for wetlands. We'll hear more about that later.

So why do we have classifications? There's a great variety of wetlands in the United states, we all know that. There are intra-regional factors and inter-regional factors that conspire to create high variability in wetlands in the United States. It's a conspiracy, folks. Why do we classify? We classify because it's our way of trying to deal with these mutually exclusive things we're trying to do. There were several attempts years ago to develop a set of indices for assessment models for assessing all wetlands as if they were one. A wetland evaluation technique that treated all wetlands the same. It didn't care if it was a coastal marsh, or a high mountain meadow, or a riparian wetland–it said they all functioned the same and it applied the same models to each one. But with HGM, we can develop classifications. So we classified to reduce the level of variability. Classifying allows us to specify relevant functions to those classes; it reduces the number of model variables that we have to deal with; it simplifies the assessment models; and it reduces the time requirement for the end user. That's the payoff! Instead of having to look at a method that deals with all the wetlands in the United States, and has all these irrelevant variables in it, it's very specific. You're dealing with only what you need to deal with. The downside of that, of course, is that you have many different specific methods. And you have to pick out the right one to use. What's wrong with some of the existing classifications? Well, there's nothing wrong with some of the existing classifications. There are hundreds of wetlands classifications out there. Well, we felt that some weren't dealing with the functional relationships that were in wetlands. And we feel vindicated now, knowing that Ralph Tiner and some of the other people involved with developing some of these methods are now retrofitting them to include geomorphic factors.

So why hydrogeomorphic classifications? Hydrology and geomorphology strongly influence how a wetland functions, we think. Therefore, we base our classifications on 3 things: the source of water (where the water comes from); hydrodynamics (how the water moves through the wetland); and geomorphic setting (where the wetland sits/what its landform is). Water sources can be precipitation, overland flow, groundwater or interflow, shallow groundwater interflow, or overbank backwater types of flooding situations. In any specific wetland, or any wetland class, there may be more than one of these, but usually one of these dominates. So here's a schematic of that. We have precipitation-driven depression there, we have a groundwater-driven depression, we have an over bank flow riverine system, where you get an overbank system.

Hydrodynamics refers to how the water moves through the system. How high-energy is it? What direction is it moving? Is it moving vertically, as it would in a depressional type of wetland? Is it unidirectionally downstream, as it would be in most riverine systems?

The third major factor is the geomorphic setting. There are 5–depression, fringe, slope, flat, and riverine. This is my classical depression slide. This is a depression. Depressions are holes in the ground. Water moves toward the center of the depression. The fluctuation is up and down. It could be precipitation-driven or it could be groundwater-driven, that makes it fluctuate up and down. The second geomorphic setting is the fringe. Now this is around the edges of those depressions. Now we're talking about this wetland fringe around a deep water system. So, again, out here we have a large lake. A deep lake. But fringing it, we have all this emergent material here, and submerged aquatic wetland plant species. This can also be a fringe on an ocean coastal kind of setting. The third geomorphic setting is the slope. These are the wetlands that occur on the sides of hills, basically. Generally, the source of water in these systems is groundwater of some kind, either interflow or some type of shallow groundwater flow. This is a classic slope wetland in the Midwest; I believe it's Savage Fen in Minnesota. Basically, what you have is a source of water up on a plateau. The water infiltrates, percolates through, hits an impervial layer somewhere down here, and moves laterally down this slope. And this is a pretty constantly wet slope, it's a fen, it's a slope wetland. If you go west, slope wetlands look a lot different. This is Red Meadow Creek in Montana, this is an avalanche hill that formed out there, and this is a slope wetland. It's basically precipitation-driven, but it's very different from a fen. The fourth kind of geomorphic setting is a flat. We have a controversy about what's a flat and what's a slope so we've come up with a new one called "flope." That's half flat and half slope, because in any classification, the devil's in the details. The problem comes when you get slopes that start to merge into flats. When does a flat become a slope, and when does a slope become a flat? Well, it's got a lot to do with a lot of different things, and you're never going to identify it down to the exact degree. But flats, if you go with the kind of concept here, are like these pine flatwoods in the Atlantic coastal plain. You have a large flat area and the driving hydrologic factor is generally precipitation (these are really large regional slopes). Water flows very slowly just below the surface in many cases, and it fluctuates based on precipitation. So the difference between flats and slopes just gets fuzzy in the middle. Another example of a flat is the organic flats up in the northern country. You get a lot of peat accumulation and large extensive flat areas of organics developing. The fifth major geomorphic classification is riverine. This one's pretty straightforward; again a Western example is Flathead River in Montana–a classic Western stream. And here's more of an Eastern example in Connecticut. So it's a riverine geomorphic setting–everyone understands that.

So based on those factors–water source, hydrodynamics, and geomorphic setting–we define 7 wetland classes at a continental or national scale. Depression, coastal fringe, lacustrine fringe, slope, mineral flat, organic flat, and riverine. If you take a look at these classes, and look at them on a landscape, you can see that you have depressions that exist out here, isolated, you can have depressions that are part of a slope that turn into depressions, that turn into riverines, there are lateral slopes. You have another depression or maybe a fringing; you can have a riverine with overbank flooding down here, where you have slopes moving out to flats at the bottom. You can pinpoint on the landscape how all these classes fit together.

The problem with a national class level is, it doesn't get you down to the level of detail that you need to actually do functional assessment. We're coming back to the Wet-2 syndrome. Someone wants to develop a set of procedures for riverine wetlands. Well, there's a riverine wetland out here somewhere that I would submit, out here there's a flood plain. Now I'll transport you from Montana to Mississippi. This is a riverine wetland, except that the active floodplain in this case is a mile wide. From a functional perspective, is *this* riverine wetland similar to *this* riverine wetland? I'd say, well, maybe in some insignificant way, but largely, no. So, you have to take the classification another step. And this is what freaks everybody out; we've developed a classification system that takes you to the edge, and then pushes you over. We can identify the major classes on a continental scale, but you're on your own when it comes to applying them on a regional scale. You have to make your own decisions. So applying the hydrogeomorphic classifications to a specific geographic area allows–we're empowering you–allows identification of regional wetland subclasses. For example, within the context of a region, you may identify within the riverine class something like high graded, with coarse sediments. You may decide that's different enough that it should be called a regional subclass. Or, you may also decide that low gradient is another regional subclass. And on and on.

Hydrogeomorphic classification takes you to a continental scale, tells you what things to look for, and then pushes you off the edge; that is, if you want to use it on a regional scale, you've got to make some decisions. You have to decide how many regional subclasses you have. And what's going to drive those decisions? Well, it's the level of detail you want. If you want real detail, create a hundred subclasses. You can do it easy. We had a workshop in New England where they created 256 different classes of slope wetlands. That's what they came out with as a recommendation. Then they said it was too many and they needed to scale back. You can get into real lumper-splitter arguments here. There can be the top-down versus the bottom-up styles of approach. There are lots of classifications that take a top-down approach. Is it possible to classify the entire country and put everything into pigeonholes? We looked at that approach for HGM, asking if it is possible to identify all regional classifications possible for HGM. We decided it's impossible. So we opted for this bottom-up approach that says, you start from some core geographic area, and you begin to identify some of the regional sub-classes that you like. And then you push that geographically out from that core area until you encounter differences that are significant enough to begin to identify a new regional subclass. And this is all going to be driven by objectives and all different kinds of things. So, HGM is a bottom-up approach.

Reference wetlands are a group of wetlands that encompass a range of variability exhibited by a regional wetland subclass that you've selected. Variability in reference wetlands is also natural processes and disturbances. So many times when you talk about functional assessment, mitigation, and all that stuff, people start talking about what I call the 2 sources of change: natural processes and disturbances. Now I love grouping those together, but if a tornadic wind knocked down half of the St. Francis-Marion Forest in the Carolinas, it's a natural process, but it looks a lot like a clearcut in some ways. So when you hear me talking about disturbance and natural process, I'm meaning natural things, and when I say alteration, I mean human-induced. Variability results from these 2 kinds of sources. The trick in HGM (and just about everything else in this world), is to distinguish between the 2. How do we distinguish between natural processes and alterations caused by people?

We have this lexicon we've developed, something called "reference domain." We have "reference wetlands," "reference *standard* wetlands," and "reference standard conditions." The reference domain is simply the geographic area from which reference wetlands are selected. So you go out and identify a bunch of wetlands that you're going to sample, and the geographic area that you're going to select those wetlands in is your reference domain.

Reference wetlands are all the wetlands of that regional subclass that exist in that reference domain, regardless of whether they're undisturbed or highly disturbed. This is a little switch. It confuses a lot of people. When a lot of people think "reference wetland" they think of the best, the blue ribbon, the gold standard. That's not the case in HGM. Our reference wetlands are all wetlands in a regional subclass, regardless of whether they're highly altered or the most pristine thing out there. On this schematic it shows we've got a national park with some really undisturbed wetlands that are part of the reference wetland data set; we've also got some sites that are either in developed watersheds and watersheds that are affected by agriculture, watersheds that are affected by urbanization; those are still part of the reference wetland data set.

The reference standard wetlands are the standard of comparison that you're using in measuring functional capacity. In this case, they're the least disturbed wetlands in the least disturbed landscapes. That's a reference *standard* wetland. Now, all of you are going to get terribly confused, because in the IBI system, when they say "reference wetland" it means the same thing as when we in the HGM system say "reference standard wetland." It's a conspiracy. It really is. So, reference wetlands are everything, regardless of their functional capacity, and reference standards are the ones we're comparing; they're the denominator.

Reference standard conditions are the conditions that exist in reference standard wetlands. Species composition, hydrologic regimes, etc. etc.

Why use reference wetlands? We use reference wetlands to establish a range of variability within a regional wetland subclass–to establish a basis for defining what constitutes characteristic sustainable levels of function across the suite of functions that are performed by that regional subclass; to provide the standard of comparison for assessing functional capacity. We use reference wetlands to provide data for calibrating model variables. In HGM, we use it to provide data for validating functional indices, and we use it to provide concrete examples of abstract concepts. An important thing of reference wetlands is to be able to grab the novice regulator (or anybody who is unfamiliar with wetlands) and say, "This is the best we've got of this regional subclass. Look at it. Get a feel for it." Let them look at it, let them see what big trees there are. Let them see what water 7 feet deep on a floodplain is. And then take them to a channelized site, or a site that's been clearcut, and say "Do you see a difference between these 2? That's a highly functioning wetland, this is NOT a highly functioning wetland." That's important.

The third major component is the index itself. I'm going to make short shrift of this, but I just don't have much time. I'll give you the general concepts. What is a functional capacity index? It's an estimate of the capacity of a wetland to perform a function relative to reference standard wetlands. The least disturbed, in the least disturbed landscape. So we develop an index that looks at the functional capacity of a specific wetland, in the numerator, and compare it to the functional capacity of that reference standard. In HGM, this is an important point. Even though we're doing an assessment of function, we are in essence doing that assessment in the context of the wetland ecosystem because we set the standards of comparison using reference standard wetlands. Therefore, we are doing, in essence, an assessment of wetland ecosystems, NOT wetland ecosystem functions, because we assess the suite of functions that are performed by that wetland. On the face of it, because of 404, we are charged with measuring change as wetland functions–that's what we're supposed to do. Well, there's lots of ways to do that. Depending on what you set this standard of comparison to be.

If I set the standard of comparison to be the least disturbed wetland in the least disturbed landscape, and the characteristic level of function that those wetlands perform, I always have a benchmark that I'm going back to. I'm comparing any wetland in the reference domain against that standard. Believe me, that causes a lot of problems. Why? Because it forces people to deal with the fact that all they may have in their area is crummy wetlands. The index is scaled from zero to one, so if the best wetland is a 0.2, it doesn't sound very good. As a wetland ecologist, what I want to know is not whether or not this is the best wetland you have. What I want to know is, where does this wetland sit in the larger population of wetlands out there? And what could this wetland be? If you don't establish a standard of comparison that relates to what you could restore that wetland to, you're undermining your ability to do mitigation and restoration. And this is all my opinion. I don't speak for the Corps of Engineers on this point.

So, I want to see a standard that is established as high as possible, based on what can potentially be restored in that watershed, or in that region. And if you start futzing with how you define this standard of comparison, which several states are doing, the whole thing falls apart, because no longer can I do a comparison. I might get a set of indices that are based on a standard that is the least disturbed wetland in the least disturbed landscape. But someone else might get indices based on a degraded site as their standard. We both may get the same indices, but you can't compare them. It just opens this Pandora's Box, so we need a standard of comparison. Several years ago I developed the concept of non-negotiable items in HGM. This is a non-negotiable item in my opinion. We will not negotiate on what this denominator is. It is the least disturbed in the least disturbed landscape. So if someone is doing HGM, ask them what they set up as their denominator.

What does a functional capacity index consist of? Model variables, which are characteristics and processes that influence a function. These could be landscape- or ecosystem-based. There's an assessment model, which is a simple mathematical equation that defines the relationships between model variables and functional capacity. Forget the indicator part, the measures used to quantify or qualify those model variables. So for example, it looks something like this, the function that we're looking at here is to temporarily store surface water. The characteristics that we're interested in for this function are the frequency of overbank flooding, the volume of storage in the wetland, and the resistance to waterflow. Those are the things that we think are influencing how this function is performed in riverine wetlands. For example, the metrics that we use to measure these characteristics are recurrence interval, ratio of flood plain width to channel width, some kind of a managed roughness coefficient, and the slope of the flood plain. We combine those variables into this equation based on what we think the relationships between those variables are. I don't want to go into a lot of detail here, but we've explicitly talked a lot about how to combine these things. But this is all part of the development process with the experts sitting around the table, not the end users.

Why use functional indices? Measuring functions directly in the field is difficult. This goes back to the time and expertise constraints. Easily measured indicators, or metrics, are available for many of the factors that influence functions. Functional indices provide a tool for rapidly assessing changes in functional capacity. So we've recognized that we can't go out and put water wells in. We can't sit out there for a year and measure hydrologic regime, frequency of flooding, etc. It's ridiculous to even contemplate it in the context of 404 or just about any other assessment situation I've found. You can't do it, so you have to use a set of indices.

Developing a functional capacity index: you select and define functions, and then conceptualize that as the assessment model. You define model variables and the metrics to measure those variables. You go out and you sample the reference wetlands. You calibrate the models using those reference wetlands. You verify the model, field-test the model, and validate the model. Now, I'm specific about the use of these terms. Verify and validate are kind of wishy-washy. When I say verify, I mean, does the model do what you intended it to do? It may not be right, but does it perform the way you wanted it to perform, as the developer of the model? You need to do that for all these indices. A whole different step is the validation of that model. Validation is when you determine whether or not the model is right. In order to validate a model or an index, you have to find independent measures of function (which is what the functional capacity index is also measuring), and then do a correlation between actual quantitative measures of a function and the model output. That's what I mean by model validation.

Assessment protocols. The group of people who are doing the development phase do the classification, the index development, the collection of reference data, the calibration of the models, and then take all this information and put it into a form–a ten-page form (or less, hopefully). That is basically the way the end user takes this information and applies it. The regional guidebooks we develop basically document all that went into the development of the regional guidebook, things such as the class, the reference domain, the location of the reference wetlands, the variables, the way the assessment was put together and why, the calibration, and on and on. The regional guidebook is a set of instructions. Based on all this background material, how do you use all of these indices? There are 10 pages of field data sheets where the Corps regulator walks out into the field and answers some questions. Based on those answers, they come back, and they have completed their evaluation. So this assessment protocol, which is done by the development team, means they have to develop guidelines and methods for preparing a functional assessment, collecting the field data, analyzing the field data, and calculating the functional capacity indices. And believe me, when you look at all the effort and time that's necessary to develop a regional guidebook, it's incredible. We figure a year to a year and a half to actually do it. But this is that leveraging I talked about before. You can leverage all the time and expertise and money to get a regional guidebook developed. Once you get it developed there's a payoff, because you have a very specific product that can be used in literally less than a day on a project by a Corps regulator. And the results are tied to and based on very good science, in my opinion. You can go to court with it and win, believe me. People went to court and won with the Wet method, and this is 10 times better.

Let me talk to you for a bit about the status of the hydrogeomorphic approach. Let me begin around 1989. There were just a few people involved. Now it's gotten so big, and there's so many people involved, that I've totally lost track. If people called me to say, "We're doing a regional guidebook in Outer Slobovia," I wouldn't be surprised. But this tracks the development of documents that support hydrogeomorphic approach. Number one is a hydrogeomorphic classification, which is available on the Web site, downloadable as a "pdf" file–Adobe Acrobat. What the national guidebook does not have, is any real data in it, because it's a national guidebook. There is no reference wetland data in a national guidebook. So it's a template for somebody to take to a region and apply by inserting reference data. If I were to initiate the process of developing a regional guidebook now, I would probably go to another regional guidebook as my template rather than the national guidebook. Regional guidebooks, again, are the end product of the HGM approach for the Corps of Engineers. We're charged with putting out techniques that can be used for assessing 404 permits. We're developing regional guidebooks. Other people are using them for different reasons.

There's a national inter-agency action plan with 6 signatory agencies–basically all federal agencies involved with wetlands. That's also available on the Web site. Then there's a second version of the procedural document which is called "Guides for Developing Regional Guidebooks" where we go into excruciating detail about how to develop a regional guidebook. How do you develop functional indices? How do you put the model together? Why would you make it a geometric mean rather than an arithmetic mean? All kinds of information, 8 chapters worth. It has not been published yet, although it won't be long.

This shows where we're familiar with regional guidebooks that are actually being developed in the United States. The legend shows what national class it is, recognizing that it's been regionalized. We have work going on in a lot of places–mostly riverine right now, some depression, some where multiple classes are being developed. Those are the kinds of things that are going on. If you have specific questions, the Web site has a listing of each of these with details about who's the point of contact, specifics of what they're doing, and where they are in the process.

Is HGM for use only in the Corps? It is not. It's a tool that is out there for them to select and use if they want to. Is it too complicated a tool to be invoked in 404? We don't think so. Again, we make a very simple to use tool after we put in a fair amount of effort up front and leverage that against the time constraints in the 404 process. Should the HGM approach not be used until it's implemented nationwide? Well, that's silly, because the place where the rubber meets the road is at the level of the regional guidebook and that has nothing to do with whether or not there's a regional guidebook in another state, or anywhere else in the world for that matter. Can it only be applied to real jurisdictional wetlands? Well that's false too, because we don't assess jurisdiction of wetlands, that's another charge we're supposed to do in 404, but we say we can't do that. In order to do a functional assessment, we have to assess the wetland ecosystem. We assess the ecosystem, and then apply the results of the ecosystem assessment back to the jurisdictional wetland, which may only be a small part of that wetland ecosystem. Does the number of regional subclasses make it impractical? Well, you get what you pay for. If you want a technique with high resolution, you have to do classification at a level that is meaningful. Are wetlands too variable in time and space to make assessments practical? Yeah, that's true. Are there no pristine or undisturbed wetlands to serve as reference standards? We think that's false. If you really start looking at historical data, you can generally put together some kind of characterization on what these systems used to look like. As a matter of fact, if I can find pretty much unaltered wetlands in the lower Mississippi River Valley, you can find them anywhere. Are reference data too expensive to collect? Well, that's right. Are wetlands bundles of functions that can be stored, managed, or traded independently? They can't. We're assessing ecosystem function, not individual functions. This gets into that trap of what do you put into that denominator. If you assess a wetland ecosystem, what goes into that denominator may be very different from if you assess a specific function. And if that didn't make any sense to you, talk to me. Will the HGM approach result in loss of wetlands because of lower mitigation ratios? I don't know what it's going to result in, but my concern is, I want to know what the change in this wetland is in relation to some reference standard. If that means that you call this wetland a 0.2 (really low quality), well, that's because it is low quality. That doesn't mean it's not valuable, that's the whole value thing. You may decide to assign very high value to functions that perform at very low levels, if you're in an urban setting or something else. That's fine. But don't change the way you assess the functions based on your value judgements out here. Keep assessment of function and assignment of value as 2 separate things. Don't mix the 2 up. That's what gets you into all kinds of trouble.

Some say the HGM approach is no better than BPJ. I disagree. Does the HGM approach preclude the use of other methods? Again, I disagree. We're finding very good success when using HGM in the context of larger watershed analyses and landscape-scale assessments, even in conjunction with IBI's.

This is a matrix that shows the different levels you need to put into the assessment of functions to get out certain levels of resolution. If you're interested in that slide, I don't think it's on the handout, but there's a couple of things that may get you down the road in terms of how you're planning here in Indiana. I do want to mention one more thing. One of the things that we're trying to do here is to do a comparison of different kinds of assessment techniques, and it's important to understand how they relate to each other and what their objectives are in the process of going through the assessment. Here are 2 methods–the Index of Biological Integrity (Jim Carr's stuff and all the things that developed as a result of that), and the hydrogeomorphic approach. There's a lot of confusion out there in terms of what IBI is. They wonder if they need to develop water quality standards for wetlands. That's what EPA is trying to do now. Since they basically use IBI for water quality standards for streams and rivers, they think the logical thing to do is to use IBI for wetlands. We could just move it from streams up the gradient to wetlands. Well, there are a lot of reasons why you can't do that, in my opinion. The development of those wetland water quality standards has been put into an HGM vs. IBI context, and that's inappropriate. Hopefully I can tell you why. IBI was developed to assess integrity–biological integrity. Jim Carr will correct you in a meeting if you say it's ecological integrity. It is not ecological integrity. It is biological integrity. (I'm not an IBI expert, so if I get something wrong here, somebody who knows a lot about this, correct me; but this is my understanding.) In the process of assessing biological integrity, we're really saying that at a specific site, the biology, the organisms, integrate the landscape. They're saying that the biological organisms that occur in a stream–and this is a reach–tell you everything that's going on upstream. If there's a high-quality watershed, if there's a low quality watershed, whatever. So it's biological integrity, and it's really focused on a landscape scale.

That's very different from the hydrogeomorphic approach. We don't proclaim to do integrity directly in the hydrogeomorphic approach. Number one, we're not assessing integrity; we're assessing functions. Change in functions. And we're charged to do it by 404 on a site-specific scale as it relates to a project. That's very different. But there's a lot of similarity. Both of these systems (even though they have a different intent and objective) go through the same sequence of steps. They both develop a reference data set, they both develop standards–those reference standards for the denominator in the indices. They both develop a set of indices. In the case of IBI, it's a single index. In the case of HGM, it's multiple indices for different functions. They both calibrate those indices based on the reference data that was collected. So the end result is where they kind of part ways again. Because what you get out of IBI is a measure of integrity in relation to a reference. That's what IBI gives you, but it gives it to you solely in the context of biological integrity. Now I think Jim Carr would say that you can use that to go backwards through some logic and identify what are the physical or chemical things that may have resulted in that biological integrity. So integrity relates to the function. HGM, even though it goes through the same series of steps, gives you change in functional capacity in relation to a reference standard. That's where the 2 are different, but notice the common thread here is back to "reference standard." So I would argue that HGM is giving you a measure of functional integrity through the back door–if you don't screw around with what's in the denominator. Thank you.